



Standard Test Method for Crack-Tip Opening Displacement (CTOD) Fracture Toughness Measurement¹

This standard is issued under the fixed designation E1290; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—Figure 1 was editorially revised in March 2010.

1. Scope

1.1 This test method covers the determination of critical crack-tip opening displacement (CTOD) values at one or more of several crack extension events, and may be used to measure cleavage crack initiation toughness for materials that exhibit a change from ductile to brittle behavior with decreasing temperature, such as ferritic steels. This test method applies specifically to notched specimens sharpened by fatigue crack-ing. The recommended specimens are three-point bend [SE(B)], compact [C(T)], or arc-shaped bend [A(B)] specimens. The loading rate is slow and influences of environment (other than temperature) are not covered. The specimens are tested under crosshead or clip gage displacement controlled loading.

1.1.1 The recommended specimen thickness, B , for the SE(B) and C(T) specimens is that of the material in thicknesses intended for an application. For the A(B) specimen, the recommended depth, W , is the wall thickness of the tube or pipe from which the specimen is obtained. Superficial surface machining may be used when desired.

1.1.2 For the recommended three-point bend specimens [SE(B)], width, W , is either equal to, or twice, the specimen thickness, B , depending upon the application of the test. (See 4.3 for applications of the recommended specimens.) For SE(B) specimens the recommended initial normalized crack size is $0.45 \leq a_o/W \leq 0.70$. The span-to-width ratio (S/W) is specified as 4.

1.1.3 For the recommended compact specimen [C(T)] the initial normalized crack size is $0.45 \leq a_o/W \leq 0.70$. The half-height-to-width ratio (H/W) equals 0.6 and the width to thickness ratio W/B is specified to be 2.

1.1.4 For the recommended arc-shaped bend [A(B)] specimen, B is one-half the specimen depth, W . The initial normalized crack size is $0.45 < a_o/W < 0.70$. The span to width ratio, S/W , may be either 3 or 4 depending on the ratio of the inner

to outer tube radius. For an inner radius, r_1 , to an outer radius, r_2 , ratio of > 0.6 to 1.0, a span to width ratio, S/W , of 4 may be used. For r_1/r_2 ratios from 0.4 to 0.6, an S/W of 3 may be used.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- E4 Practices for Force Verification of Testing Machines
- E8/E8M Test Methods for Tension Testing of Metallic Materials
- E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials
- E1820 Test Method for Measurement of Fracture Toughness
- E1823 Terminology Relating to Fatigue and Fracture Testing
- E1921 Test Method for Determination of Reference Temperature, T_o , for Ferritic Steels in the Transition Range

3. Terminology

3.1 Terminology E1823 is applicable to this test method.

3.2 Definitions:

3.2.1 *crack-tip opening displacement, (CTOD), $\delta[L]$* —the crack displacement resulting from the total deformation (elastic plus plastic) at variously defined locations near the original (prior to an application of force) crack tip.

3.2.1.1 *Discussion*—In common practice, δ is estimated for Mode I by inference from observations of crack displacement nearby or away, or both for the crack tip. In this test method,

¹ This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.07 on Fracture Mechanics.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.